actuator mechanisms for a multi-touch tactile touch panel. Those of ordinary skilled in the art will realize that the following detailed description of the present invention is illustrative only and is not intended to be in any way limiting. Other embodiments of the present invention will readily suggest themselves to such skilled persons having the benefit of this disclosure.

[0022] Reference will now be made in detail to implementations of the present invention as illustrated in the accompanying drawings. The same reference indicators will be used throughout the drawings and the following detailed description to refer to the same or like parts.

[0023] In the interest of clarity, not all of the standard hardware and routine features of the implementations described herein are shown and described. It will, of course, be appreciated that in the development of any such actual implementation, numerous implementation-specific decisions must be made in order to achieve the developer's specific goals, such as compliance with application- and business-related constraints, and that these specific goals will vary from one implementation to another and from one developer to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking of engineering for those of ordinary skilled in the art having the benefit of this disclosure.

[0024] The present invention discloses an electronic interface device using multi-touch actuator mechanisms for a touch panel. In one embodiment, the interface device having a tactile touch panel is capable of providing multiple haptic feedbacks in response to multiple contacts simultaneously. The haptic feedback may also be referred to as tactile effect, tactile feedback, haptic effect, force feedback, or vibrotactile feedback. The tactile touch panel can also be referred to as a haptic touch pad, vibrotactile touch panel, force feedback touch panel, haptic touch panel, or the like.

[0025] The tactile touch panel, in one embodiment, includes an electrical insulated layer and a tactile layer, wherein the electrical insulated layer includes a top surface and a bottom surface. The top surface of the electrical insulated layer is capable of receiving an input from a user. The tactile layer, which is also known as a haptic layer, a feedback layer, or the like, includes a grid or an array of haptic cells. The top surface of the haptic layer is situated adjacent to the bottom surface of the electrical insulated layer, while the bottom surface of the haptic layer is situated adjacent to a display. Each haptic cell further includes at least one piezoelectric material, Micro-Electro-Mechanical Systems ("MEMS") element, thermal fluid pocket, MEMS pump, resonant device, variable porosity membrane, laminar flow modulation, or the like. Each haptic cell is configured to provide a haptic effect independent of other haptic cells in the tactile layer.

[0026] FIG. **1** illustrates an electronic interface device or system **100** capable of providing multiple tactile feedbacks in response to multiple touches substantially simultaneous in accordance with one embodiment of the present invention. System **100** includes a touch-sensitive panel or touch panel **102**, a display panel **104**, and a case **106**. Touch-sensitive panel **102**, in one embodiment, is made of substantially transparent materials, and is capable of transmitting light so that objects or images displayed in display **104** can be seen through the touch-sensitive panel **102**. Display **104** can be any type of display such as a cathode ray tube ("CRT"), liquid crystal display ("LCD"), plasma display, flat panel display, flexible display or the like. Both touch-sensitive panel **102** and display **104** may be installed together with case **106**. It should be noted that touch-sensitive panel **102** and display **104** can be integrated into the same unit or device. In an alternative embodiment, display **102** may be removed from system **100** when displaying images are not necessary. For example, a touch pad used on a laptop or on a vehicle dashboard, which does not require displaying images, can be opaque.

[0027] Touch panel **102**, in one embodiment, includes an insulated layer and an array or a grid of haptic cells **120**, wherein haptic cells **120** are separated by borders **124**. Each of haptic cells **120** is capable of providing a haptic effect in response to an input independent of other haptic cells **120** in touch panel **102**. For example, when multiple contacts are depressed on touch panel **102** substantially simultaneously, touch-sensitive panel or touch panel **102** activates haptic cells **120** to generate multiple haptic effects in response to the multiple contacts. It should be noted that the multiple contacts may be made by one finger or multiple fingers. The dimension or size of each of the haptic cells **120** is configured to be less than 5 millimeters×5 millimeters, although other sizes may be used as appropriate. Touch panel **102** accepts a user's selection(s) when one or more cells **120** are contacted, touched or depressed by the user's finger(s). In one embodiment, touch panel **102** rejects a user's selection when a border **124** is touched.

[0028] Touch panel **102** further includes circuits **110** mounted at the edge or otherwise attached to the panel via a cable or flexible circuit. Circuits **110** are used to provide digital control signals and/or a power source to haptic cells **120**. In one embodiment, case **106** further includes a digital processing unit for data processing. In another embodiment, touch panel **102** is capable of providing a tactile overlay that includes a grid of haptic cells **120** wherein each of the haptic cells **120** is approximately the size of half (½) a fingertip. Each haptic cell **120** is capable of providing vibrotactile or kinesthetic feedback through a localized strain. In one embodiment, the grid cells can be hexagonal or any other type of two-dimensional (2-D) configurations. Alternatively, it should be noted that the grid of haptic cells **120** does not necessarily cover the entire touch panel surface. The layout of haptic cells **120** can be selectively configured to meet the application's requirements.

[0029] FIG. **2** illustrates a top view of an interface device **200** illustrating a haptic touch panel **206** having an array or a grid of haptic cells **210** in accordance with one embodiment of the present invention. Referring back to FIG. **2**, device **200** further includes circuit blocks 202-204, which are configured to perform various functions such as maintaining power supplies, transmitting control signals, and/or controlling fluid flow. In one embodiment, device **200** also includes a display, which is placed behind touch panel **206**. In one embodiment, touch panel **206** is substantially transparent thereby the images displayed by the display can be viewed through touch panel **206**. When the application does not require displaying images, the surface of touch panel **206** is opaque and blocks most of the light from passing through touch panel **206**.

[0030] An array of haptic cells **210** of touch panel **206** is capable of generating haptic effects in response to their control signals. Control signals, in one aspect, are generated in accordance with the inputs received. To provide multiple haptic effects in response to multiple touches, each haptic cell